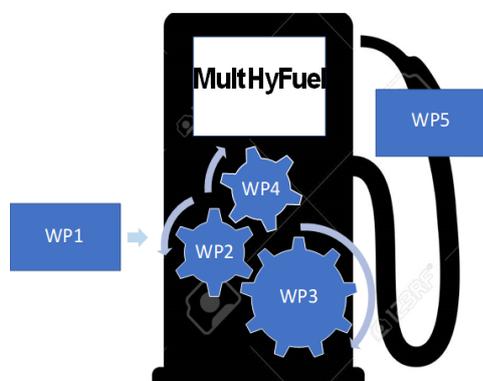


MultHyFuel: Safety and Permitting for Hydrogen at Multifuel Retail

About MultHyFuel:

The goal of MultHyFuel is to contribute to the effective deployment of hydrogen as an alternative fuel by developing a common strategy for implementing Hydrogen Refueling Stations (HRS) in multifuel contexts, contributing to the harmonization of existing laws and standards based on practical, theoretical and experimental data as well as on the active and continuous engagement of key stakeholders.

Figure 1: Goal of MultHyFuel



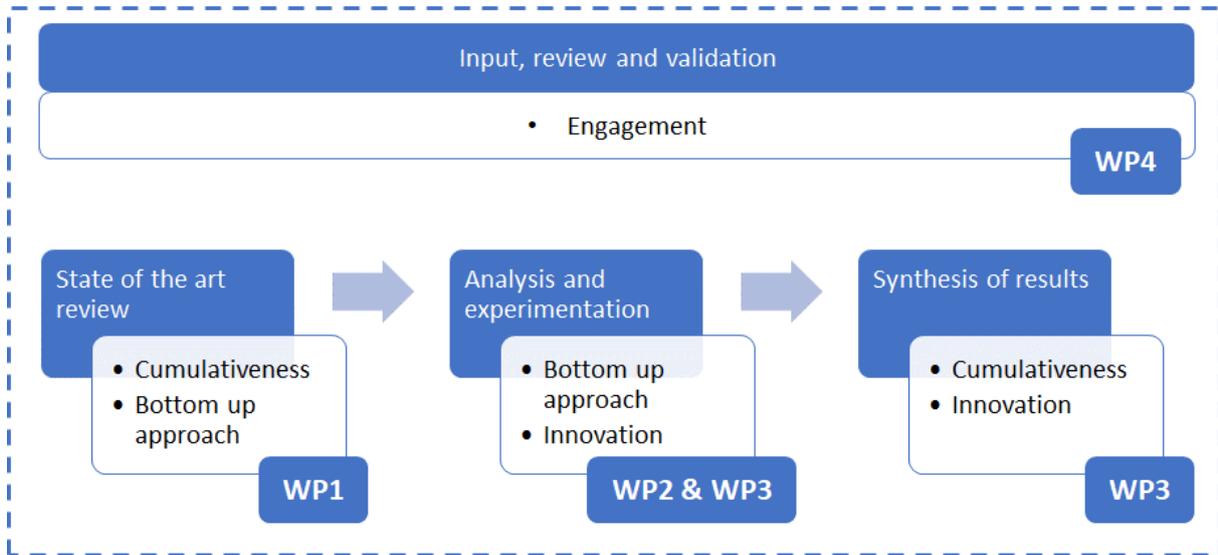
Goal: to contribute to the effective deployment of hydrogen by

- Helping develop a common regulatory framework for implementing HSR in multifunctional contexts, contributing to the harmonization of existing laws and standards
 - based on practical, theoretical and experimental data
 - as well as on the active and continuous engagement of key stakeholders

The key elements characterizing the main workstreams are:

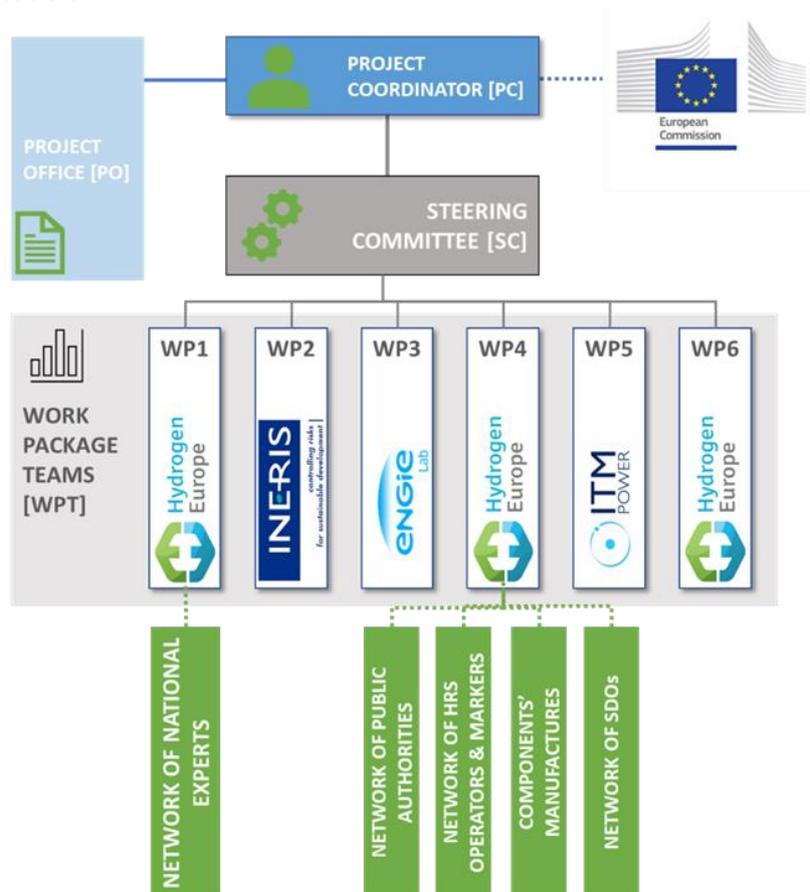
- WP1: A state-of-the-art-review phase, conducted with the support of the Network of National Experts, will realize a preliminary diagnosis of the existing rules, standards and best practices in the domain.
- WP2: Practical research and experimental laboratory work to address gaps in current understanding
- WP3: Generation of best practice guidance based on results in terms of data and evidence derived from practical experimentation and subsequent analysis, transforming the analysis and experimentation results into actionable information.
- WP4: Engagement of key target stakeholders (namely policy makers, public authorities, standardization bodies, etc. This phase will guarantee the actual involvement of target stakeholders from the very initial analysis phases up to the validation of the final results; this phase will be of primary importance to create actual commitment and shared consensus around the project results, and consequently guarantee their sustainability in the long run.
- WP5: A specific workstream is dedicated to the dissemination, communication, and exploitation of project results

Figure 2: Project Overview



Hydrogen Europe is the overall coordinator of the project (WP6), joining an international consortium which includes: Ineris (FR), Engie (FR), ITM Power (UK), Shell (NL), SNAM (IT), KIWA (NL), ZSW (DE).

The figure below shows a simplified organizational chart of the project together with the relevant Work Package Leaders.



Work Package 1 description:

This WP will be dedicated to the definition of the common knowledge of the legislative framework in which the project is undertaken. It is based on an extensive investigation on permitting requirements and guidance on risk assessment on a selected sample of target countries, to conduct a comparative assessment of the state of the art and identify relevant gaps in this domain;

Under WP1, the project will benefit from the collaboration of an ad-hoc created Network of National Experts in the domain, selected among major European national Hydrogen associations and agencies (from Austria, Belgium, Bulgaria, Finland, France, Germany, Hungary, Italy, Netherlands, Poland, Spain, Sweden, United Kingdom, Norway) whose expertise will allow gathering direct and effective insights on the situation of a representative set of countries.

Experience from implementing the HyLaw project has shown that relevant data is not always easily accessible. Often, an accurate technical response requires experience in the field and knowledge not only of applicable hydrogen specific rules and but also of general rules which have to be interpreted in an HRS context. A complete response requires a mix of desk research and interviews. Data collection at national level is to be done by experts in the area who know where to find data and what general rules are applicable. In addition, interviews with HRS operators and public authorities are typically needed to complement desk research. For this purpose, data will be collected at the national level by a Network of National Experts to be ad hoc involved. The methodology will involve (i) desk research of existing documents, rules, guidance, and published materials, (ii) primary data collection using interviews with public authorities and HRS developers.

Building on existing data already compiled and on, new, primary data collection, national experts will investigate and compare, in detail:

- I. permitting requirements, zoning, accidental scenarios, and leak size, and
- II. public guidance on risk assessment methodologies covering HRS permitting across 14 EU Countries.
- III. Other relevant requirements applicable to the process of co-locating HRS alongside other fuels

The analysis of the data provided by each national expert will provide a comprehensive cross-country review of existing permitting requirements, highlighting in particular, differences, gaps, and commonalities, and will construct the common research framework of the project.

Thanks to these activities, WP2 and WP3 will be able to adapt their proposed methodology to ensure that areas where significant differences in rules or where gaps exist (e.g. due to the absence of experimental data on risk assessments) are covered by the work in both WPs. In particular, the best practice guidelines to be drafted under WP3 will pay close attention to cover the areas where significant differences in rules or where gaps exist.

According the project schedule, WP1 should be complement within the first 9 months of the project.

Work Package 2 description:

WP2 will perform an experimental and numerical research campaign aimed at better assessing the risk level of these critical scenarios. This campaign will be focused on:

- **refueling hydrogen dispenser** by characterising;
 - the hydrogen leak (flow rate & frequency) by means of a fluid-mechanical model that will be developed and confronted to experiments during this project;
 - the hydrogen gas dispersion and flammable cloud formation both within and outside the dispenser by means of numerical tools (tools not already used during WP3);
 - the ignition probability using a theoretical approach confronted with literature review;
 - the consequences of this ignition (jet fire, explosion...) by doing experiments;
 - the efficiency and response time of several safety barriers (breakaway, water deluge...) using an experimental approach.
- **other surrounding dispensers** (petrol, gasoline, NGV) by characterising;
 - the maximum expected thermal and overpressure effects experienced by the hydrogen dispenser due to a fire and/or explosion caused by one of the other fuel dispensers based on previous experiments and on the available literature;
 - The vulnerability of the hydrogen dispenser to this type of challenges by means of experiments.

Based on all outcomes from WP2, WP3 will review the positioning of all critical scenarios in the risk matrix and, if some of them remain critical, will introduce safety barriers (zoning or technical barriers whose efficiency was estimated during WP2) to act favourably on their positioning in the matrix. This introduction will be made once by once to assess their impact on the overall risk level of HRS. Once this overall risk will be eventually acceptable, all recommendations hence deduced will be gathered in the best practice guidance.

Work Package 3 description:

Since the very initial stages of this workstream, **WP3 will define the technical configuration for the HRS** that will be investigated throughout this project; then the following steps will be achieved:

- Following a review of state-of-the-art technologies for HRS, WP3 will define up to three case study models in order to have relevant example systems for the risk analysis. Based on the project and facilities from the industrial partners, the output will be up to three detailed process flow diagrams representing the possible configurations of refuelling stations with their equipment (examples of HRS configuration: H2 mobile storage supply of the fuel station / H2 production onsite with electrolyser supplying H2 / liquid H2 station) and set of activity (as retrofit of classical petroleum station, multi fuel stations for buses or trucks (LNG, CNGG, H2...));
- WP3 will conduct a preliminary risk assessment to identify the accidental release scenarios arising from hydrogen but also from other fuels that could cause escalation to the hydrogen dispenser;
- After reviewing the different existing methodologies, WP3 will carry out a risk assessment mainly consisting in assessing the occurrence frequency and the consequence of the release scenarios. WP3 will build a risk matrix (scales for gravity and frequency, number, and meaning of risk level) with three different risk acceptance levels (acceptable, non-acceptable, As Low As Reasonably Possible). This matrix will be shared by all partners. Any

scenario whose risk is found to be unacceptable will be considered as “critical” and will be thoroughly analysed in WP2. Indeed, this statement may result from a too conservative assessment of the occurrence frequency and/or consequence. The first parameter is often deduced from existing databases - not always directly relevant to HRS - while the second parameter may be determined by modelling tools - not always precise enough to account for the complex environment of the dispenser.

The ultimate goal of WP3 will be to *Generate best practice guidance*. Such best practice guidance is expected to be used as a common approach to risk assessments (e.g. related to zoning, separation distances, etc.) addressing the permitting requirements as well as safe designs for HRS in a multi-fuel context. Moreover, these activities will support communication about the harmonized approach of mitigation measures for multi-fuel stations. This work will be conducted by primarily summarizing the results produced under the previous phase and in close cooperation with the community of stakeholders engaged under WP4. Such results will be elaborated in a way to maximize their applicability, specifying -where relevant- the conditions that would allow their applicability and the impact and benefits expected from their implementation. This will facilitate the communication of the results towards key stakeholders and actual use in decision making contexts.

The expected results of this task are to develop best practice guidelines that can be used to determine:

- The most appropriate approach to risk assessments and addressing the permitting requirements,
- The most appropriate safe design(s) for hydrogen refuelling stations in a multi-fuel context. (safety barriers identified in risk assessment tasks),
- Layout recommendations between the dispenser and the other components of the refuelling station (e.g. storage tanks, compressors, etc.),
- Recommendation about hazardous area around H2 dispenser.

Work Package 4 description:

Under WP4, the consortium will constitute an active and engaged community of public authorities, HRS operators and makers component manufacturers and standards developing organisations (SDOs), which will be consistently involved the full life-cycle of the project and creation of project outcomes, from input provision (ensuring the widest possible coverage of different countries and sector maturities' perspectives) up to co-design and validation of the results produced; this continuous engagement will progressively be built commitment and agreement around the guidelines produced, which will ensure the long term sustainability and impact of the MultHyFuel results, primarily in terms of decision-makers endorsement at both national and European level.

Hence, by leveraging on the top-level players in the hydrogen sector involved as project partners, as well as in the direct engagement and collaboration with national associations and primary stakeholders in the sector, the project will ensure a **unique convergence of expertise, competences, and capabilities, which will maximize the value of the results produced.**

The engagement with key stakeholders will enable a bi-directional line of communication, ensuring:

- That the project team informs key stakeholders, at each stage of the process, about the status and results of the project, and
- That key stakeholders become involved with the work by providing the project team with comments and suggestions, in a co-creation perspective.



Figure 3 - Overview of preliminarily identified stakeholders to be engaged under WP4

The active engagement of such a community will be ensured through the realization of dedicated workshops and bilateral contacts via email, phone as well as via documentary exchange. In particular, HE will define the most appropriate format for each workshops' organization (in terms of agenda and activities) and will, in collaboration with the relevant WP/task leader, define the documentation to be provided to stakeholders in preparation for the event, as well as the follow-up actions (e.g. questionnaire) to collect further inputs. Among the approaches that will be considered to implement the above mentioned workshops there will be the worldcafé format (to allow stakeholders to focus on different aspects in the same workshop and gather a stock of inputs), round tables on specific aspects (for short inputs stock taking), and brainstorming discussions (for validation/review of aspects related to methodologies and approaches selected by the project). These approaches will allow concretizing valuable intelligence to be gathered from involved stakeholders and experts and to customize project results according to actual state-of-the-art and end-users' perspective. The underpinning aim is to bring different views on the same issue and use participatory techniques to mobilise distinct sorts of knowledge while building consensus and ownership around devised solutions, maintaining user-centred perspective in an iterative input, review, and validation process.

Each approach will be selected based on the primary aim of the workshop in object and on the project results to be commented or validated. In each case, the involved stakeholders will receive preparatory material before the actual realization of the workshop (to allow the stakeholders to

express informed opinions and considerations) and will be contacted after the workshop realization for follow up consultation and clarification of relevant points, where needed. If appropriate for the purposes of each phase, the consortium will define specific short questionnaires on the material shared before the workshop or follow up questionnaires, to gather comparable inputs from the stakeholders.

This activity will allow to gather input and validate the results produced under WP1, WP2, and WP3. The engagement enabled by WP4 will result in a key stakeholder community that is more likely to take-up the project results beyond the project implementation (e.g. policy making/HRS development/component design), hence fostering its medium and long-term sustainability. Moreover, the results of the project will enable public authorities across EU to develop rules based on scientific evidence and common, agreed assumptions for hazardous area classification for hydrogen dispensers. It will vastly simplify the process of designing and permitting standardised hydrogen dispensers which will lead to a greater degree of harmonisation of requirements for the permitting of hydrogen dispensing alongside other fuels, thus:

- (i) reducing cost and
- (ii) ensuring that hydrogen dispensing can be co-located with other fuels safely.

According to the project schedule, the first workshop under WP4 is scheduled to take place in month 6 and is aimed towards HRS makers and operators in order to validate analysis of the state-of-the-art in HRS design and the HRS test models that will form the basis of the experimental work in WP 2.

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Call Identifier FCH-04-1-2020: Overcoming technical and administrative barriers to deployment of multi-fuel hydrogen refuelling stations (HRS)

Members of the MultHyFuel consortium:



